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## REVIEWS

**How and Why the Sugar Maple Bleeds**

For several years the botanists and chemists of the Vermont Experiment Station, assisted by sundry students of the University of Vermont, have been studying certain phenomena associated with maple sap flow. The details of this work are available in a bulletin recently issued.\* Some of the more interesting facts and conclusions follow, but only a small portion of these can here be mentioned.

Maple sap is practically a solution of sugar in water with traces of mineral and flavoring matters. The sugar content averages nearly 3 per cent., but this varies with tree and season. Seasonal variations are related to foliage development and climatic conditions. Foliage variations may be considerable. Thus the same tree which carried 8,846 square feet of leaf surface in 1899 developed 14,930 feet in 1900. The variations in sap composition between individual trees is even more noteworthy, extremes varying from 1.33 per cent. to 8.20 per cent. being recorded. The trees having larger tops and fuller exposure to light yield richer sap as a rule. There are however large differences where conditions and vigor of the trees appear identical and one must believe that there is individuality in the productiveness of maple trees much as there is in that of milch cows. The average yield per tree in a good season is about three pounds of sugar, which probably represents less than 4 per cent., of the entire sugar content of the tree.

The time and rate of sap-flow are directly related to seasonal conditions and temperature variations. Whenever during late winter and early spring sudden fluctuations occur in temperature in the vicinity of 0° C., sap flow begins. Flow develops with rise of temperature above this and ceases with its fall. These interrelations between sap movements and temperature variations were closely followed by attaching pressure gages, such as are commonly used on steam boilers, to gas pipes screwed into maple trunks. The flow of sap into such pipes develops pres-

\* Jones, C. H., Edson, A. W. and Morse, W. J. The Maple Sap Flow. Vt. Exp. Sta. Bull. No. 103. December, 1903. Obtainable from the Experiment Station, Burlington, Vt.

sure which corresponds to the rate of flow in tapped trees. By employing self-recording gages and thermometers complete seasonal records have been obtained which reveal a striking parallelism in the fluctuations of pressure and of temperature. This has led some to explain the phenomenon of sap pressure and flow as due simply to the expansion with rise of temperature of the gas imprisoned within the woody tissues ; but the fluctuations observed in pressure and suction are far greater and more sudden than this physical explanation can account for. Thus variations are frequent in these gage records of ten or fifteen pounds pressure with a change of but a few degrees in temperature. Extreme fluctuations are recorded of nearly thirty pounds to the square inch, within twenty-four hours, viz., from 5 pounds suction to 22 pounds pressure. A rise of over twenty pounds in pressure was observed with a rise in air temperature of only two degrees, which would mean even less increase in tree temperature. The conclusion is that sap-flow in the sugar maple is a true bleeding phenomenon, attributable to the vital activities of living cells. The pressure shown by the gage is simply a partial expression of the energy of the countless living, working protoplasts of the maple stem.

There is little evidence of "root-pressure" ; in fact on good "sap days" the flow into the tap hole comes chiefly from above downwards. We must regard the stem tissues as chiefly active, the cells in the vicinity of the tap hole operating alternately as suction and force pumps, so to speak, sucking the sap from root and remoter stem tissues and forcing it out through the tap hole.

It is not difficult to conceive how a rise of temperature past a critical point for their vital activities should arouse or stimulate the bleeding activities of the cells and how a fall below this point should check them. The suction thereupon developed would seem to be due to osmotic reabsorption of the exuded sap by the same cells.

L. R. JONES.

## PROCEEDINGS OF THE CLUB

WEDNESDAY, FEBRUARY 24, 1904

This meeting was held at the New York Botanical Garden ; Professor Underwood in the chair ; sixteen persons present.